Reference 2
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CLAIMS

[Claim(s)]
[Claim 1] An optical probe device which obtains an optical tomogram using low coherence light, comprising:
A flexible sheath with the tip side transparent at least.
Said outgoing radiation and incidence part of a low interference light provided in said sheath lumen
Housing for holding said said outgoing radiation and incidence part of a low interference light.
A flexible shaft which is connected with said housing and transmits rotation from a driving means of a rear end part.
A friction prevention means which is established between said sheath point inner face and said housing tip, and prevents friction at the time of rotation of said housing.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention irradiates analyte with low coherence light, and relates to the optical probe device for building the tomogram for analyte from the information on the lights scattered in analyte.
[0002]
[Description of the Prior Art] In recent years, when diagnosing a body tissue, OCT (optical coherence tomography) of the interference pattern which obtains the tomogram to analyte is indicated by for example, the Patent Publication Heisei No. 511312 [six to] gazette, using low coherence light as a device which can acquire the optical information of an in-house part.
[0003]In the Patent Publication Heisei No. 511312 [six to] gazette, the optical probe device (it is only hereafter written as an optical probe or a probe) which has the rotation tube with which the tip unit which serves as an optical fiber, and optical outgoing radiation and an incidence part inside to the tube shape sheath of the outside for inserting into the abdominal cavity was provided is indicated.
[0004]
[Problem(s) to be Solved by the Invention]However, in the conventional optical probe, it is the tip clearance of the point inner face of a tube shape sheath, and the apical surface of a tip unit. [When the crevice was large, the way person's operativity worsened at the time of observation,

when tip clearance was small, and the solid of revolution of a sheath tip part and an inside ran, rotationability fell and there was a fault -- a proper OCT picture is no longer acquired.

[0005]An object of this invention is to provide the optical probe device which was made in view of the point mentioned above, can make tip clearance the minimum, can set up and hold tip clearance at a proper position, and can hold stably the axis of rotation of outgoing radiation and the incidence part of a low interference light.

[0006]

[Means for Solving the Problem]In an optical probe device with which an optical probe device of this invention obtains an optical tomogram using low coherence light, A flexible sheath with the tip side transparent at least, and said outgoing radiation and incidence part of a low interference light which were provided in said sheath lumen, Housing for holding said said outgoing radiation and incidence part of a low interference light, and a flexible shaft which is connected with said housing and transmits rotation from a driving means of a rear end part, A friction prevention means which is established between said sheath point inner face and said housing tip, and prevents friction at the time of rotation of said housing is provided, and it is constituted.

[0007]By said friction prevention means being established between said sheath point inner face and said housing tip, and preventing friction at the time of rotation of said housing in an optical probe device of this invention. Tip clearance is made into the minimum, tip clearance can be set up and held at a proper position, and it makes it possible to hold stably the axis of rotation of outgoing radiation and an incidence part of a low interference light.

[0008]

[Embodiment of the Invention] Hereafter, an embodiment of the invention is described with reference to drawings.

(A 1st embodiment) Drawing 1 thru/or drawing 4 start a 1st embodiment of this invention, The lineblock diagram showing the entire configuration of the optical imaging instrument with which drawing 1 was provided with the optical probe device, the figure in which drawing 2 shows the endoscope in which the optical probe device of drawing 1 is inserted, the lineblock diagram in which drawing 3 shows the composition of the optical probe device of drawing 1, and drawing 4 are the lineblock diagrams showing the composition of the important section of the optical probe device of drawing 3.

[0009]The optical imaging instrument (optical fault image device) 1 shown in drawing 1 has formed the low coherence light sources 2, such as a super-high-intensity light emitting diode (the following, SLD, and brief sketch), in the observation device 27. That wavelength is 1300 nm and this low coherence light source 2 is provided with the feature of low coherence light which shows coherence only in the short range scale of as [whose coherence length of that is about 17 micrometers].

[0010]That is, when the difference of two light path length to the point mixed from the point which branched when it was mixed again, after branching this light to two is in the short range scale which is about 17 micrometers, it is detected as a light in which it interfered, and when light path length is larger than it, the characteristic in which it does not interfere is shown.

[0011]The light of this low coherence light source 2 enters into the end of the 1st single mode

fiber 3, and is transmitted to the end face (apical surface) side of another side. Image formation of this 1st single mode fiber 3 is carried out in the intermediate optical coupler part 4 as optically as the 2nd single mode fiber 5. Therefore, it is branched and transmitted to two in this optical coupler part 4.

[0012]In the tip (optical coupler part 4) side of the 1st single mode fiber 3. The optical rotary joint 6 which performs combination which can transmit light by the non rotating part and a rotary part is inserted, At the tip of the 3rd single mode fiber 7 in this optical rotary joint 6, an optical probe device of a 1st embodiment. (The following and an optical probe brief sketch) The connector area 9 of 8A can detach and attach freely, and it is connected, and it is inserted in in this optical probe 8A, and the light of the low coherence light source 2 is transmitted to the 4th single mode fiber 10 to rotate (light guide).

[0013]And the transmitted light is irradiated, being scanned from the tip side of the optical probe 8A at the body tissue 11 side as analyte. A part of catoptric light carried out, such as dispersion the surface or inside the body tissue 11 side, is incorporated, It returns to the 1st single mode fiber 3 side through a reverse optical path, the part moves to the 2nd single mode fiber 5 side by the optical coupler part 4, and it enters into the photo-diode 12 as a photodetector from the end of the 2nd single mode fiber 5. The rotor side of the optical rotary joint 6 is rotated with the rotary drive 13.

[0014]The variable mechanism 14 of the light path length who changes the light path length of standard light is formed in the tip side from the optical coupler part 4 of the 2nd single mode fiber 5. 1st light-path-length change means by which only the light path length of this scanning zone changes at high speed corresponding to the light path length to whom this light path length's variable mechanism 14 scans only a predetermined scanning zone to the depth direction of the body tissue 11 with the light-scanning probe 8, It has the change means of the 2nd light path length who can change the light path length about the variation in the length so that the variation in the length of each optical probe 8A at the time of exchanging and using the optical probe 8A can be absorbed.

[0015]It counters at the tip of the 2nd single mode fiber 5, and is attached on the 1 axis stage 18 with this tip, and the grating 16 is arranged via the collimate lens 30 which can move in the direction shown in the arrow a freely. moreover -- passing this grating (diffraction grating) 16 and the corresponding lens 17 -- a minute angle -- the rotatable galvanometer 19 being attached as the 1st light path length's change means, and, By the galvanometer controller 20, this galvanometer mirror 19 vibrates in rotation at high speed, as the numerals b show.

[0016]This galvanometer mirror 19 is reflected by the mirror of a galvanometer, and the mirror which impressed the driving signal of exchange to the galvanometer and was attached to that movable part is vibrated in rotation at high speed.

[0017]That is, a driving signal is impressed by the galvanometer controller 20 so that only a predetermined distance can be scanned at high speed to the depth direction of the body tissue 11 with the optical probe 8A, and as the numerals b show with this driving signal, it vibrates in rotation at high speed.

[0018]And it is emitted from the end face of the 2nd single mode fiber 5 by this rotation vibration, and only the scanning zone of a predetermined distance which the light path length

of the light which is reflected by the galvanometer mirror 19 and returns scans to the depth direction of the body tissue 11 changes.

[0019]That is, the change means of the 1st light path length for obtaining the tomogram for a depth direction is formed by the galvanometer mirror 19. The change means of the light path length by this galvanometer mirror 19 is indicated by SCIENCE VOL.276, 1997, and pp2037-2039.

[0020]The 2nd single mode fiber 5 and collimate lens 30 are provided on the freely movable 1 axis stage 18, as the numerals a show to the optical axis direction, and they serve as the 2nd light path length's change means.

[0021]The fiber loop 29 for the polarization plane control for removing the influence of the birefringence produced by bending of the whole interference system which comprises a fiber, and the fiber in the optical probe 8A is formed in the 2nd single mode fiber 5.

[0022]On the other hand, the 1 axis stage 18 forms the variable means of the 2nd light path length who has a variable range of only the light path length who can absorb the variation in the light path length of the optical probe 8A to the case where the optical probe 8A is exchanged, and. The position considered as a request when ****(ing) light path length by the galvanometer mirror 19 and acquiring the picture of a depth direction. (For example, even when the tip of the optical probe 8A has not stuck on the surface of a body tissue, by changing the light path length by the 1 axis stage 18) He is trying to also have the function of an adjustment device to adjust offset so that it can image from the surface position, by setting it as the state of interfering from the surface position of the body tissue 11.

[0023]This 1 axis stage 18 is provided with the motor for stage movement, and moves in the direction shown with the numerals a in the 1 axis stage 18 by impressing a driving signal to that motor with the position control apparatus 21.

[0024]It is mixed with the light which leaked from the 1st single mode fiber 3 side in the coupler part 4 provided in the middle of the 2nd single mode fiber 5, and the light into which light path length was changed by this light path length's variable mechanism 14 is received with both the photo-diodes 12.

[0025]The light path length from the optical coupler part 4, for example to [after the 2nd single mode fiber 5 has set up the 1 axis stage 18 near the mid-position of the variable range / from the tip of the optical probe 8A] the body tissue 11 through the 4th single mode fiber 9 grade, pass the 2nd single mode fiber 5 -- the light path length reflected by the galvanometer mirror 19 on the 1 axis stage 18 -- abbreviation -- it is set up become equal length.

[0026]And by carrying out variable setting out of the position of the 1 axis stage 18 according to the optical probe 8A used actually connecting, By absorbing the variation in the length of each optical probe 8A (the 4th inner single mode fiber 10), and rotation vibrating or high-speed vibrating the galvanometer mirror 19 at high speed, and changing periodically the light path length of the standard light side, The catoptric light in the depth position of the body tissue 11 used as a value equal to this light path length is made to interfere, and it enables it to make the catoptric light in other depth portions into noninterfering.

[0027]After the signal by which photoelectric conversion was carried out with the above-mentioned photo-diode 12 is amplified by AMBU 22, it is inputted into the demodulator

23. In this demodulator 23, recovery processing which extracts only the signal part of light in which it interfered is performed, and that output is inputted into the computer 25 through A/D converter 24. The image data corresponding to a tomogram is generated, it outputs to the monitor 26, and the OCT image 26a is expressed to that display surface as this computer 25.

[0028]This computer 25 is connected with the position control apparatus 21, and the computer 25 controls the position of the 1 axis stage 18 via the position control apparatus 2. The computer 25 is connected with the video synchronous circuit 28, and tomogram data is stored in an internal memory synchronizing with the video synchronizing signals at the time of imaging.

[0029]The video synchronizing signals of this video synchronous circuit 28 are sent also to the galvanometer controller 20 and the rotary drive 13, respectively, For example, the galvanometer controller 20 outputs a driving signal with the cycle in sync with video synchronizing signals (the 1st high-speed video synchronizing signals [in / specifically / two video synchronizing signals a high speed and a low speed,]), The rotary drive 13 outputs the driving signal which synchronized with the 1st video synchronizing signals with the cycle in sync with video synchronizing signals (specifically the 2nd low-speed video synchronizing signals), and he is trying to scan light to a hoop direction by rotation by the rotary drive 13.

[0030]The optical probe 8A of a 1st embodiment can make the tip side of the tip opening to the optical probe 8A project through the channel for forceps insertion from the forceps insertion port 32 of the endoscope 31, as shown in drawing 2.

[0031]It has the flexible insert portion 33 by thin length so that it may be easy to insert this endoscope 31 into the abdominal cavity, and the wide-width final controlling element 34 is formed in the back end of this insert portion 33. The forceps insertion port 32 is formed near the back end of this insert portion 33, and this forceps insertion port 32 is open for free passage with the channel for forceps insertion by that inside.

[0032]The light guide which is not illustrated is inserted in in the insert portion 33, the incidence edge of this light guide is connected to light equipment, it is emitted from the lighting window which transmitted the illumination light and was provided in the tip part of the insert portion 33, and the affected part etc. are illuminated. A lighting window is adjoined and an observation port is provided, and an objective optical system is attached to this observation port, and it enables it to observe the affected part etc. which were illuminated to an optical system. And it irradiates with low coherence light, the fault image data inside the body tissue 11 is obtained, and it enables it to display the OCT image 26a on the display surface of the monitor 26 with the optical probe 8A under observation of the observation optical system of the tip part of the endoscope 31 at the body tissue 11 side of the portion which the affected part etc. observe.

[0033]The bend 35 and (endoscope) the tip part 36 are formed in the tip part of the insert portion 33. When making the tip 37 of the optical probe 8A project from the endoscope tip part 36 and making [making the optical probe 8A insert through the bend 35, and] the body tissue 11 touch, as shown in drawing 2, the tip part 36 of the optical probe 8A curves with a small curvature radius.

[0034]The optical sheath 38 in which the optical probe 8A comprised a tubular resin tube in

which a tip peripheral face is transparent and long and slender at least as shown in drawing 3, The connector area 9 which connects the end face side of this optical sheath 38 to the rotary drive (an observation device is constituted) 13, The flexible shaft 40 which comprises the coil 44 which was provided inside the optical sheath 38 and rolled spirally and which rotates free and transmits torque, The 4th single mode fiber 10 provided in the lumen of the flexible shaft 40, It has with the rotation transmission connector 42 connected to the back end of the flexible shaft 40 which has the tip unit 39 which serves as optical outgoing radiation and an incidence part by which connection maintenance is carried out at the tip of the flexible shaft 40, and the optical connector (not shown) connected to the back end of the 4th single mode fiber 10.

[0035]The GRIN lens 45 which condenses the light from the end of the 4th single mode fiber 10 in the tip unit 39 which is blockaded in watertight by a sealed part, can rotate the tip of the optical sheath 38 freely to the tip side of this optical sheath 38, and is arranged, The prism 51 which reflects the condensed light on a slant face, and is emitted to rectangular directions is formed, These are covered with the tip housing (only housing brief sketch) 52 which has the window part 46 used as outgoing radiation and the incidence part of the light from the prism 51 (it is attached at the tip of the flexible shaft 40, and is ****).

[0036]In rotation the rotation transmission connector 42 within the connector area 9 by being held free and watertight, also making the connector area 9 into watertight construction, and the whole optical probe 8A's being watertight construction, and using [it is / the index matching water for acid resisting / full, and] it for an inside, (It makes for the difference of the refractive index by the refractive index of small air in the meantime to be in a large state into the almost same refractive index with index matching water to the prism 51 of the optical unit 39, and the refractive index of a sheath) Reflection in the interface of them is reduced, The optical probe 8A is simply disinfected with an antibacterial etc., it inserts (passing the channel of direct or an endoscope), and use has become possible [make it possible to acquire the good OCT image of image quality, and] in the abdominal cavity (since it is watertight construction).

[0037]The rotary drive 13 which the connector area 9 of the back end of this optical probe 8A can detach and attach freely, and is connected has the optical rotary joint 6 to which the rotation transmission connector 42 is connected. The above-mentioned optical connector (not shown) connected to the back end of the 4th single mode fiber 10 is formed in this rotation transmission connector 42, and this optical connector and the optical rotary joint 6 are connected to the 3rd single mode fiber 7.

[0038]And the light transmitted by the 3rd single mode fiber 7 is transmitted to the 4th single mode fiber 10 by an optical connector. The rotation by the rotary drive 13 is transmitted to the flexible shaft 40 by the rotation transmission connector 42.

[0039]The transmit light of the 4th single mode fiber 10 is transmitted to the tip unit 39, Total internal reflection is carried out by the prism 51 of this tip unit 39 on that slant face, an emission direction is changed into rectangular directions, and a tip peripheral face is emitted outside as inspection light through the transparent optical sheath 38 via the window part 46 at least. And the catoptric light from a body tissue is received and it transmits to the 4th single mode fiber 10 again. Since the tip of the FUREKISHIBU shaft 40 is connected to the tip unit 39, the flexible shaft 40, the tip unit 39, and the 4th single mode fiber 10 rotate by one.

[0040]As shown in drawing 4, the metal sphere 61 is embedded at the tip of an inner surface of the optical sheath 38 of this embodiment in part, and the point of contact 62 of the metal sphere 61 is carrying out point contact to the apical surface 63 of the tip housing 52.

[0041]That is, since the portion exposed from the inner surface tip of the optical sheath 38 of the metal sphere 61 has touched at the tip smooth side and point of the housing 52, there is little frictional resistance of the housing 52 and the line which connects a point contact point and a center with the metal sphere 61 is rotated as an axis. For this reason, clearance at the tip of the housing 52 and the tip of an inner surface of the optical sheath 38 can be made into the minimum, stabilizing rotation of the housing 52 uniformly.

[0042]Since the metal sphere 61 can be the X ray imaging target at a tip, it is carrying out roentgenography and can get to know the tip position of the optical sheath 38 correctly.

[0043]Since rotation of the housing 52 is uniformly stabilized in order to carry out point contact of the metal sphere 61 embedded at the tip of an inner surface of the optical sheath 38 to the apical surface of the tip housing 52 according to this embodiment described above, Since a proper OCT image is acquired and the window part 46 which are outgoing radiation and an incidence part of light can be close brought at the tip of the optical sheath 38 in the minimum clearance, a way person's operativity improves at the time of observation.

[0044]Although the housing 52 is reflected to X-rays, and optical sheath 38 portion of the point is not reflected to X-rays, since X ray imaging of the metal sphere 61 provided at optical sheath 38 tip is carried out, the operativity at the time of inserting in a fine lumen organ under radioscopy improves.

[0045](A 2nd embodiment) Drawing 5 thru/or drawing 8 are involved in a 2nd embodiment of this invention, The lineblock diagram in which drawing 5 shows the composition of the important section of an optical probe, the lineblock diagram in which drawing 6 shows the composition of the important section of the 1st modification of the optical probe of drawing 5, the lineblock diagram in which drawing 7 shows the composition of the important section of the 2nd modification of the optical probe of drawing 5, and drawing 8 are the lineblock diagrams showing the composition of the important section of the 3rd modification of the optical probe of drawing 5.

[0046]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0047]As shown in drawing 5, in the optical probe 8B of this embodiment, the friction prevention member 65 is embedded at the tip of an inner surface of the optical sheath 38 in part in a sheath, and the curved surface which has exposed this friction prevention member 65 within the optical sheath 38 is the convex 66. The apical surface of the housing 52 is made into the concave surface 67.

[0048]The curvature radius of the convex 66 of the friction prevention member 65 is made smaller than the curvature radius of the concave surface 67 of the apical surface of the housing 52. Therefore, with the same operation as a 1st embodiment, fitting of a rugged surface can constitute a bearing and blur of the housing 52 at the time of rotation can be made small. Other composition is the same as that of a 1st embodiment.

[0049]Since the axis of rotation of the housing 52 is stabilized [according to this embodiment

described above] more in addition to the effect described by a 1st embodiment and the peripheral surface of the housing 52 can be certainly prevented from contacting the inner surface of the optical sheath 38, a more proper OCT image is acquired.

[0050]As the 1st modification of the optical probe 8B, as shown in drawing 6, the convex 66 of the friction prevention member 65 may be formed in the height 68a of the sealing cap 68 which closes the tip of the optical sheath 38 watertight at one, Same operation and effect can be acquired by carrying out point contact of the concave surface 67 of the apical surface of the housing 52 to the convex 66 of the sealing cap 68.

[0051]As the 2nd modification of the optical probe 8B, as shown in drawing 7, the curved surface exposed within the optical sheath 38 of the friction prevention member 65 currently embedded at the tip of an inner surface of the optical sheath 38 in part is made into the concave surface 69, The apical surface of the housing 52 may be made into the convex 70, and it may constitute so that the curvature radius of the concave surface 69 of the friction prevention member 65 may be made larger than the curvature radius of the convex 70 of the apical surface of the housing 52, Same operation and effect can be acquired by carrying out point contact of the concave surface 69 of the apical surface of the housing 52 to the convex 70 of the friction prevention member 65.

[0052]As the 3rd modification of the optical probe 8B, as shown in drawing 8, The concave surface 69 of the friction prevention member 65 may be formed in the sealing cap 68 which closes the tip of the optical sheath 38 watertight at one, and same operation and effect can be acquired by carrying out point contact of the concave surface 69 of the apical surface of the housing 52 to the convex 70 of the sealing cap 68.

[0053](A 3rd embodiment) Drawing 9 is a lineblock diagram showing the composition of the important section of the optical probe concerning a 3rd embodiment of this invention.

[0054]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0055]As shown in drawing 9, the angular ball bearing 72 is formed in the optical sheath 38 inner-surface side of the end cap 71 which closes the tip of the optical sheath 38 watertight, the heights 73 are formed in the apical surface of the housing 52, and it comprises the optical probe 8C of this embodiment. Other composition is the same as that of a 1st embodiment.

[0056]In order that according to such composition there may be less friction, rotation may be stabilized, since a peripheral face ****** and rotates to each ball of the angular ball bearing 72 at the heights 73 of the apical surface of the housing 52, and rotation unevenness may decrease, a still more suitable OCT image is acquired.

[0057]Since the axis of rotation of the housing 52 is stabilized [according to this embodiment described above] more in addition to the effect described by a 1st embodiment and the peripheral surface of the housing 52 can be certainly prevented from contacting the inner surface of the optical sheath 38, a more proper OCT image is acquired.

[0058](A 4th embodiment) Drawing 10 is a lineblock diagram showing the composition of the important section of the optical probe concerning a 4th embodiment of this invention.

[0059]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0060]As shown in drawing 10, in the optical probe 8D of this embodiment. The opening of the tip of the optical sheath 38 is carried out, it forms in the housing 52 the thin diameter section 75 which made the back end side thin, supports the outside surface 75a of this thin diameter section 75 by the bearing 76 which adhered to the tip opening inner surface of the optical sheath 38, and connects it with the flexible shaft 4. In addition. The end face 52a in which the thin diameter section 75 of the housing 52 was formed is in contact with the bearing 76.

[0061]The tip opening of the optical sheath 38, the terminal area of the bearing 76, and the housing 52 are stored in the surrounding body 77 of the cylindrical shape which consists of watertight and transparent construction material. The tip side of this surrounding body 77 is closed with the end cap 79 which formed the heights 78 in the portion inserted in the wall of a surrounding body, and is made to carry out point contact of the heights 78 and the crevice 80 provided at the tip of the housing 52.

[0062]As long as the surrounding body 77 has a good light transmittance state, it may not necessarily be a flexible raw material, and as long as the optical sheath 38 is flexible, it may not necessarily be a good raw material of a light transmittance state. Other composition is the same as that of a 1st embodiment.

[0063]Since according to this embodiment described above in addition to the effect described by a 1st embodiment the thin diameter section 75 of the housing 52 is supported by the bearing 76 and the axis of rotation of the housing 52 is stabilized more, blur and rotation unevenness of the housing 52 decrease and a still more suitable OCT picture is acquired.

[0064]Since the peripheral surface of the housing 52 can be certainly prevented from contacting the inner surface of the optical sheath 38 and it can prevent with the crack of the surrounding body 77, a picture does not deteriorate.

[0065]The raw material set by the characteristics, such as a required light transmittance state and pliability, by each part with the surrounding body 77 and the optical sheath 38 can be selected.

[0066]Since the end face 52a in which the thin diameter section 75 of the housing 52 was formed is in contact with the bearing 76, the housing 52 can be arranged with sufficient accuracy in a desired position.

[0067](A 5th embodiment) Drawing 11 thru/or drawing 17 are involved in a 5th embodiment of this invention, The lineblock diagram in which drawing 11 shows the composition of the important section of an optical probe, the 1st explanatory view in which drawing 12 explains an operation of the optical probe of drawing 11, The 2nd explanatory view in which drawing 13 explains an operation of the optical probe of drawing 11, the lineblock diagram in which drawing 14 shows the composition of the important section of the 1st modification of the optical probe of drawing 11, The lineblock diagram in which drawing 15 shows the composition of the important section of the 2nd modification of the optical probe of drawing 11, the lineblock diagram in which drawing 16 shows the composition of the important section of the 3rd modification of the optical probe of drawing 11, and drawing 17 are the lineblock diagrams showing the composition of the important section of the 4th modification of the optical probe of drawing 11.

[0068]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0069]As shown in drawing 11, in the optical probe 8E of this embodiment. The bearing 83 which has the concave surface 82 which touches the convex 81a of the tip part 81 provided in the apical surface of the housing 52, and serves as a bearing of the convex 81a of the tip part 81 at the time of rotation, It has the spring 85 which is an elastic body which connects the elastic body attaching part 84 embedded at the point inner face of the optical sheath 38, and the elastic body attaching part 84 and the bearing 83, and is constituted. Other composition is the same as that of a 1st embodiment.

[0070]In this embodiment, since the convex 81a of the tip part 81 and the concave surface 82 of the bearing 83 are contacted by the fixed pressure with the spring 85, blur at the time of rotation can be decreased further.

[0071]As opposed to the distance L1 of the direction of a longitudinal shaft of the elastic body attaching part 84 at the time of un-curving [which shows drawing 12 the optical probe 8E], and the housing 52, By the difference in the elasticity of the flexible shaft 40 and the optical sheath 38, generally the distance L2 of the direction of a longitudinal shaft of the elastic body attaching part 84 at the time of the curve shown in drawing 13 and the housing 52 is set to $L1<L2$, and the housing 52 separates it from the tip of the optical sheath 38 a little in the direction of a longitudinal shaft. However, since the bearing 83 (concave surface 82) touches with the convex 81a of the tip part 81 of the housing 52 with the elasticity of the spring 85 also in such a case, blur at the time of rotation can be decreased.

[0072]Since the axis of rotation of the housing 52 is stabilized [according to this embodiment described above] more in addition to the effect described by a 1st embodiment, blur and rotation unevenness of the housing 52 decrease and a still more suitable OCT picture is acquired.

[0073]Even if it incurvates the optical probe 8E, since the bearing 83 (concave surface 82) touches the tip convex 81 of the housing 52 with the elasticity of the spring 85, the axis of rotation can be maintained, blur at the time of rotation can be decreased, and a suitable OCT picture is acquired.

[0074]As the 1st modification of the optical probe 8E, as shown in drawing 14, The composition that the spring 85 is held to the sealing cap 86 which closes the tip of the optical sheath 38 watertight may be used, and same operation and effect can be acquired by carrying out point contact of the bearing 83 (concave surface 82) to the tip convex 81 of the housing 52 with the elasticity of the spring 85.

[0075]As the 2nd modification of the optical probe 8E, as shown in drawing 15, It may provide in the apical surface of the housing 52 at the tip concave surface 87, and the convex 88 made [the tip concave surface 87 of the housing 52] to carry out point contact to the bearing 83 may be provided and constituted, Same operation and effect can be acquired by carrying out point contact of the bearing 83 (convex 88) to the tip concave surface 87 of the housing 52 with the elasticity of the spring 85.

[0076]As the 3rd modification of the optical probe 8E, as shown in drawing 16, The spring 85 is held to the sealing cap 86 which closes the tip of the optical sheath 38 watertight, It provides

in the tip concave surface 87 like the 2nd modification at the apical surface of the housing 52, The convex 88 which carries out point contact to the tip concave surface 87 of the housing 52 may be provided and constituted in the bearing 83, and same operation and effect can be acquired by carrying out point contact of the bearing 83 (convex 88) to the tip concave surface 87 of the housing 52 with the elasticity of the spring 85.

[0077]As the 4th modification of the optical probe 8E, as shown in drawing 17, form the angular ball bearing 89 in the apical surface of the housing 52, and. The convex 90 may be formed in the bearing 83, and the peripheral face of the convex 90 may be constituted so that each ball of the angular ball bearing 89 may be touched, Same operation and effect can be acquired by carrying out point contact of the bearing 83 (peripheral face of the convex 90) to each ball of the angular ball bearing 88 of the housing 52 with the elasticity of the spring 85.

[0078](A 6th embodiment) They are a lineblock diagram in which, as for drawing 18 and drawing 19, drawing 18 shows the composition of the important section of an optical probe with respect to a 6th embodiment of this invention, and a figure for which drawing 19 shows the modification of the bearing of drawing 18.

[0079]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0080]As shown in drawing 18, in the state where the bearing 95 is not fixed by the back end side both sides, it provides and the tip side of the housing 52 comprises the optical probe 8F of this embodiment. Other composition is the same as that of a 1st embodiment.

[0081]According to this embodiment, in addition to the effect of a 1st embodiment, rotation of the housing 52 becomes smooth and shakiness can be prevented by the bearing 95. Contact of the housing 52 and the optical sheath 38 is prevented by the bearing 95, the inner surface of the optical sheath 38 gets damaged, and breakage can be prevented.

[0082]It is good also as shape as shows drawing 19 the bearing 95, and friction prevention can be carried out more by using such shape, and a shaft position can be stabilized.

[0083](A 7th embodiment) In the composition of the conventional optical probe, when were filled up with the fluids for index matching etc. in the optical sheath 38 and air bubbles adhered to optical outgoing radiation and an entrance plane, there was a fault from which it is difficult from which to remove and a proper OCT picture is no longer acquired.

[0084]Then, next, in the optical probe filled up with the fluid in the optical sheath, it is easy to remove the air bubbles by which it was generated in optical outgoing radiation and the entrance plane at the tip, and the optical probe with which a proper OCT picture is acquired is explained.

[0085]The lineblock diagram in which, as for drawing 20 thru/or drawing 31, drawing 20 shows the composition of the important section of an optical probe with respect to a 7th embodiment of this invention, The explanatory view in which drawing 21 explains pouring of the fluid for the index matching into the optical sheath of drawing 20, The lineblock diagram in which drawing 22 shows the composition of the cellular trap of drawing 20, the lineblock diagram in which drawing 23 shows the composition of the 1st modification of the cellular trap of drawing 20, The lineblock diagram in which drawing 24 shows the composition of the 2nd modification of the cellular trap of drawing 20, The lineblock diagram in which drawing 25 shows the composition of the 3rd modification of the cellular trap of drawing 20, The 1st

explanatory view in which drawing 26 explains an operation of the optical probe of drawing 20, the 2nd explanatory view in which drawing 27 explains an operation of the optical probe of drawing 20, The lineblock diagram in which drawing 28 shows the composition of the important section of the modification of the optical probe of drawing 20, Drawing 1 with which drawing 29 explains the modification of pouring of the fluid for the index matching into the optical sheath of drawing 21, Drawing 2 with which drawing 30 explains the modification of pouring of the. fluid for the index matching into the optical sheath of drawing 21, and drawing 31 are Drawings 3 explaining the modification of pouring of the fluid for the index matching into the optical sheath of drawing 21.

[0086]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0087]As shown in drawing 20, the fluid 100 for index matching is filled with the optical probe 8G of this embodiment in the optical sheath 38, and the cellular trap 101 made from stainless steel is provided and constituted from it by the periphery of the flexible shaft 40 as a cellular passage limit means. A cellular trap fixed place is made into the part separated, for example from flexible-shaft 40 side edge part of the housing 52 about 5 mm, and is about 1 mm in width.

[0088]Here, pouring of the fluid 101 for the index matching into the optical sheath 38 is explained. As shown in drawing 21, the tube 102 for restoration is inserted into the optical sheath 38. The tube 102 for restoration is inserted until the tip touches the inside of optical sheath 38 tip. Next, it is gradually filled up with the index matching media 100, such as water, in the optical sheath 38 by the syringe 103 via the tube 102 for restoration. At this time, air falls out from the crevice between the tube 102 for restoration, and the optical sheath 38, and it will fill up with the fluid 100 from the internal tip of the optical sheath 38. Thereby, it is lost that air remains also of a viscous high fluid like water in the optical sheath 38. What is necessary is just to insert to the tip of the probe assembly which consists of the housing 52 and flexible-shaft 40 grade, after carrying out extraction of the tube 102 for restoration. What is necessary is just to draw in with the tube 102 for restoration, when removing the index matching medium 100.

[0089]As shown in drawing 22, the cellular trap 101 formed the stainless steel of cylindrical shape in the shape of C, and has fitted into the periphery of the flexible shaft 40, and other metal other than stainless steel, a plastic, silicone rubber, heat-shrinkable tubing, etc. may be used for the construction material. Other composition is the same as that of a 1st embodiment.

[0090]May form the stainless steel of flat plate shape in the shape of C, and the cellular trap 101 may constitute it, as shown in drawing 23, and, As shown in drawing 24, the stainless steel of cylindrical shape may be formed in a coiled form, and may be constituted, and the cellular trap 101 may be formed by carrying out the multiplex volume of the coil 44 which constitutes the flexible shaft 40 as further shown in drawing 25 by a position.

[0091]According to this embodiment, when the air bubbles 99 are formed between the window part 46 of the housing 52, and the optical sheath 38 (refer to drawing 20), as shown in drawing 26, the tip part of the optical probe 8G is placed upside down, and is neglected for a while. Then, it shakes at right and left greatly with the part which is distant from the tip side of the

optical probe 8G about 15 cm as shown in drawing 27. Then, the air bubbles 99 produced between the window part 46 of the housing 52 and the optical sheath 38 are broken finely, and since specific gravity is smaller than the index matching medium 100, they move to the cellular trap 101 side by operation of a centrifugal force. The air bubbles 99 broken finely pass the crevice between the cellular trap 101 and the optical sheath 38, and move to the hand side of the optical probe 8G. Although the air bubbles which moved to the hand side of the optical probe 8G and which were broken finely unite again, the air bubbles which united cannot pass again the crevice between the cellular trap 101 and the optical sheath 38 because of surface tension, but movement by the side of the tip of the optical probe 8G is prevented.

[0092]According to this embodiment described above, in addition to the effect described by a 1st embodiment, remove easily the air bubbles 99 produced between the window part 46 of optical outgoing radiation and an entrance plane, and the optical sheath 38, and. In the removed air bubbles 99, since movement by the side of the tip of the optical probe 8G can be prevented by the cellular trap 101, a proper OCT picture is acquired.

[0093]As shown in drawing 28, two or more cellular traps 101 may be formed in the periphery of the flexible shaft 40 at the predetermined intervals, and it may constitute so that the inside of the optical sheath 38 filled up with the fluid 100 for index matching may be divided into two or more partitions.

[0094]The trap of the air bubbles 99 produced between the optical sheath 38 and the flexible shaft 40 with constituting in this way is carried out for every partition between two or more cellular traps 101.

[0095]As a result, the air bubbles 99 produced in the probe back end become difficult to go into the end-of-the-probe side. The cellular trap 101 achieves the duty of a collector ring, and rotation of the flexible shaft 40 and an attitude become smooth, and. Since insertion of the housing 52 to the optical sheath 38 and the flexible shaft 40 becomes smooth and becomes easy [the forward/backward moving within the housing 52 and the optical sheath 38 of the flexible shaft 40], linear scanning and a spiral scan are attained.

[0096]Although pouring of the fluid 100 for the index matching into the optical sheath 38 is performed by the method shown in drawing 21, As shown in drawing 29 not only in this, for example, the concave 105 is formed in the circumferencial direction of optical sheath 3 tip part, and the communicating path 106 which opens the inside and outside of the optical sheath 38 for free passage is formed in this part like drawing 30. The elastic ring 107 is put on the concave 105.

[0097]And as shown in drawing 31, the connector area 9 of the rear end part of the optical sheath 38 is put into the container 108 which filled the index matching medium 100, and the suction opening gold 109 of a vacuum sucking device (not shown) is connected to the tip part of the optical sheath 38. By making the optical sheath 38 tip exterior into negative pressure with a vacuum sucking device, the elastic ring 107 expands the diameter and the communicating path 106 carries out an opening, and it fills up with the index matching medium 100, without leaving air bubbles. What is necessary is just to insert the probe assembly which consists of the housing 52 and flexible-shaft 40 grade to the tip of the optical sheath 38, after finishing being filled up with the index matching medium 100.

[0098]If negative pressure is applied to optical sheath 38 tip part like the point where it removed the elastic ring 107 or the opening of the optical sheath 38 rear end part is carried out into the air, the index matching medium 100 can be removed easily.

[0099](An 8th embodiment) In the conventional optical probe, since the coil which constitutes a flexible shaft was 1-fold volume covering the overall length, the flattery nature to rotation and an advance and retreat movement was bad, and since nonuniformity arose in a motion, there was a fault from which a proper OCT picture is not acquired. At the time of crookedness, change of the length of a flexible shaft was large and was worsening operativity (taking the large clearance at the tip of a sheath).

[0100]So, by this embodiment, the flattery nature of the rotation and the advance and retreat movement transmitted to a tip part is good, and explains the optical probe with which a proper OCT picture is acquired.

[0101]The lineblock diagram in which, as for drawing 32 thru/or drawing 36, drawing 32 shows the composition of the important section of an optical probe with respect to an 8th embodiment of this invention, The explanatory view in which drawing 33 explains an operation of the optical probe of drawing 32, the lineblock diagram in which drawing 34 shows the composition of the important section of the 1st modification of the optical probe of drawing 32, the explanatory view in which drawing 35 explains an operation of the optical probe of drawing 34, and drawing 36 are the lineblock diagrams showing the composition of the important section of the 2nd modification of the optical probe of drawing 32.

[0102]Since this embodiment is almost the same as a 1st embodiment, only a different portion from a 1st embodiment is explained.

[0103]As shown in drawing 32, the flexible shaft 40 of the optical probe 8H of this embodiment makes the coil 110 which changed the direction of a volume by turns 3-fold volume, and is constituted. Other composition is the same as that of a 1st embodiment.

[0104]As shown in drawing 33 in addition to the effect described by a 1st embodiment, even when observing the inside of the lumen organ 111 with a bend according to this embodiment, rotation and an advance and retreat movement are transmitted with sufficient flattery nature to a tip part by the flexible shaft 40 which made the coil 110 3-fold volume by turns. There are few attitudes of the overall length of the flexible shaft 40 by bend.

[0105]Thereby, since the flattery nature of rotation and the advance and retreat movement of the end of the probe is good, there is no nonuniformity in a motion and a proper OCT picture is acquired. Since there is little elasticity, an optical fiber can be protected.

[0106]Although the coil 110 which changed the direction of a volume for the flexible shaft 40 by turns is made into 3-fold volume and constituted, As shown in drawing 34, as the 1st modification, the coil 110 of the flexible shaft 40 near a tip part may be made into a double volume, it may be considered as 3-fold volume by the end face side, and the path of the housing 52 may also be constituted for it to double with a double volume.

[0107]The thin diameter section of a double volume is minimized according to the necessity for an insertion site. Also let the path of the optical sheath 38 be the shape which made the tip side thin at this time.

[0108]By the above, by a tip part, while becoming a narrow diameter, rigidity becomes small,

rigidity can be maintained by a large diameter and the flattery nature of rotation and an advance and retreat movement can be secured in a rear end part.

[0109]That is, since the tip part is thin, and the rigidity of a tip part is small, it can change freely also within a blood vessel with much winding, and as shown in drawing 35, insertion to the lumen organ 115 with thin deep blood vessel of coronary arteries or the inside of the body, bile duct, pancreatic duct, etc. of the optical probe 8H is attained. Since rigidity is maintained in the rear end part, it produces and is easy to operate unnecessary modification. Since the thin diameter section is minimized, flattery nature is good and a more proper OCT picture is acquired.

[0110]Although the coil 110 which changed the direction of a volume for the flexible shaft 40 by turns is made into 3-fold volume and constituted, As are shown in drawing 36 and it keeps away from a tip part as the 2nd modification, The coil 110 of the flexible shaft 40 is rolled one-fold, and it is considered as 3-fold [a double volume and] volume, and the thin diameter section of 1-fold and a double volume may be minimized according to the necessity for an insertion site, and may constitute the path of the housing 52 according to 1-fold volume.

[0111]By the above, while a tip part becomes a narrow diameter further, rigidity becomes small. Therefore, since the tip part is thinner, it can insert in a blood vessel, a thin lumen organ, etc. by the side of the cancellation to a pan in the living body.

[0112](A 9th embodiment) In the conventional optical probe, when a tip part curved, the perfect circle of the sheath section was not maintained, but the solid of revolution and the sheath contacted, friction became large, nonuniformity arose in rotation, and there was a fault that a proper OCT picture was not acquired.

[0113]So, by this embodiment, even if the tip part is curving, a tip part solid of revolution rotates smoothly by an optical sheath lumen, and the optical probe with which a proper OCT picture is acquired is explained.

[0114]The lineblock diagram in which, as for drawing 37, drawing 37 thru/or drawing 39 show the composition of the important section of an optical probe with respect to a 9th embodiment of this invention, the explanatory view in which drawing 38 explains the mesh ring of drawing 37, and drawing 39 are the lineblock diagrams showing the composition of the important section of the modification of the optical probe of drawing 37.

[0115]Although this embodiment can be constituted like a 1st embodiment, it explains based on the example of composition of the 2nd modification of the optical probe 8B of a 2nd embodiment. That is, this embodiment can apply basic constitution to other embodiments of other composition similarly to a 1st embodiment therefore. Since it is almost the same as the 2nd modification of the optical probe 8B of a 2nd embodiment, only a different portion from the 2nd modification of the optical probe 8B of a 2nd embodiment is explained.

[0116]As shown in drawing 37 and drawing 38, in the optical probe 8I of this embodiment, the housing 52 forms the stainless mesh ring 120 which gave a mesh to the contacting parts 119 in contact with optical sheath 38 wall. This mesh ring 120 is formed in the contacting parts 119 by adhesion or welding, avoids the field (window part 46) to which an observation beam is emitted, and is provided so that an observation beam may not be barred. Other composition is the same as the 2nd modification of the optical probe 8B of a 2nd embodiment.

[0117]Even if it uses it where a tip part is crooked when using the optical probe 8I in the abdominal cavity, inserting it, the perfect circle of a portion which formed the mesh ring 120 is maintained, and the contact portion of housing 52 and optical sheath 38 lumen can be rotated smoothly. Since the mesh ring 120 is limited and formed in the contact portion of housing 52 and optical sheath 38 lumen, it does not lose the pliability of the whole optical probe 8I.

[0118]Since the perfect circle of a portion which formed the mesh ring 120 is maintained [according to this embodiment] in addition to the effect of a 1st embodiment, smooth [of the rotation of an end-of-the-probe part] can be carried out, and a proper OCT picture is acquired.

[0119]As shown in drawing 39, by the thinner tube 121, as the mesh ring 120 is put, it may be provided, and the mesh ring 120 can be prevented from touching a living body directly in this case.

[0120][Additional remark]

1. Flexible sheath with tip side transparent at least in optical probe device which obtains optical tomogram using low coherence light, Said outgoing radiation and incidence part of a low interference light provided in said sheath lumen, and the housing for holding said said outgoing radiation and incidence part of a low interference light, An optical probe device possessing the friction prevention means which is established between the flexible shaft which is connected with said housing and transmits rotation from the driving means of a rear end part, and said sheath point inner face and said housing tip, and prevents friction at the time of rotation of said housing.

[0121]2. Optical probe device given in additional remark paragraph 1 making into concave surface or flat surface field which makes apical surface of said housing convex and touches said housing of said friction prevention means.

[0122]3. Optical probe device given in additional remark paragraph 1 making into convex field which makes tip part of said housing concave surface or flat surface, and touches said housing of said friction prevention means.

[0123]4. Optical probe device given in additional remark paragraph 1, wherein said friction prevention means is constituted by ball bearing.

[0124]5. Optical probe device of any one statement of additional remark paragraph 1 thru/or 4 provided with elastic member which one end was held at said sheath point inner face, and held said friction prevention means to the other end.

[0125]6. Said outgoing radiation and incidence part of low interference light provided in said sheath lumen in optical probe device which obtains optical tomogram using low coherence light, The housing for holding said said outgoing radiation and incidence part of a low interference light, and the transparent tubed surrounding body which includes said housing, The flexible shaft which is connected with said housing and transmits rotation from the driving means of a rear end part, An optical probe device possessing the friction prevention means which is established between the sheath which is connected to said surrounding body and includes said flexible shaft watertight, and said surrounding body tip and said housing tip, and prevents friction at the time of rotation of said housing.

[0126]7. Flexible sheath with tip side transparent at least in optical probe device which obtains optical tomogram using low coherence light, Said outgoing radiation and incidence part of a

low interference light provided in said sheath lumen, and the housing for holding said said outgoing radiation and incidence part of a low interference light, An optical probe device possessing the cellular control means established near outgoing radiation and the incidence part of the flexible shaft which is connected with said housing and transmits rotation from the driving means of a rear end part, and said light which removes the air bubbles of the index matching medium with which it filled up in said sheath, and said index matching medium.

[0127]8. Flexible sheath with tip side transparent at least in optical probe device which obtains optical tomogram using low coherence light, The housing for holding said outgoing radiation and incidence part of a low interference light provided in said sheath lumen, and outgoing radiation and the incidence part of said light, An optical probe device possessing the flexible shaft which consists of a coil member which is connected with said housing and transmits rotation from the driving means of a rear end part, and by which the multiplex volume was carried out, and the optical fiber which transmits said low interference light provided in the lumen of said pipe member.

[0128]9. Optical probe which is optical probe which has flexible sheath which includes solid of revolution and said solid of revolution, and is characterized by providing reinforcing means in said sheath portion to which said solid of revolution touches said sheath lumen.

[0129]10. In the optical probe device which obtains an optical tomogram using low coherence light, A flexible sheath with the tip side transparent at least, and said outgoing radiation and incidence part of a low interference light which were provided in said sheath lumen, The housing for holding said said outgoing radiation and incidence part of a low interference light, and the flexible shaft which is connected with said housing and transmits rotation from the driving means of a rear end part, An optical probe device providing the friction prevention means which prevents friction at the time of rotation of said housing by being provided between said sheath point inner face and said housing tip, and carrying out point contact to said housing tip.

[0130]

[Effect of the Invention]Since according to the optical probe device of this invention a friction prevention means is established between a sheath point inner face and a housing tip and friction at the time of rotation of housing is prevented as explained above, It is effective in the ability to make tip clearance into the minimum, set up and hold tip clearance at a proper position, and hold stably the axis of rotation of outgoing radiation and the incidence part of a low interference light.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]The lineblock diagram showing the entire configuration of the optical imaging instrument provided with the optical probe device concerning a 1st embodiment of this invention

[Drawing 2]The figure showing the endoscope in which the optical probe device of drawing 1 is inserted

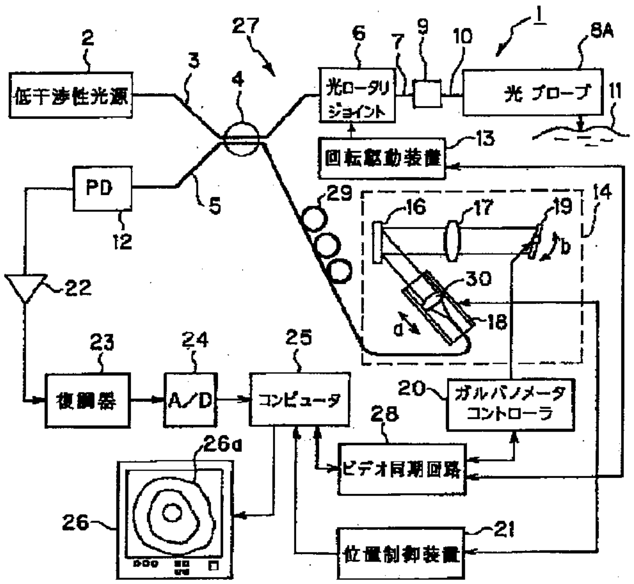
[Drawing 3]The lineblock diagram showing the composition of the optical probe device of drawing 1
[Drawing 4]The lineblock diagram showing the composition of the important section of the optical probe device of drawing 3
[Drawing 5]The lineblock diagram showing the composition of the important section of the optical probe concerning a 2nd embodiment of this invention
[Drawing 6]The lineblock diagram showing the composition of the important section of the 1st modification of the optical probe of drawing 5
[Drawing 7]The lineblock diagram showing the composition of the important section of the 2nd modification of the optical probe of drawing 5
[Drawing 8]The lineblock diagram showing the composition of the important section of the 3rd modification of the optical probe of drawing 5
[Drawing 9]The lineblock diagram showing the composition of the important section of the optical probe concerning a 3rd embodiment of this invention
[Drawing 10]The lineblock diagram showing the composition of the important section of the optical probe concerning a 4th embodiment of this invention
[Drawing 11]The lineblock diagram showing the composition of the important section of the optical probe concerning a 5th embodiment of this invention
[Drawing 12]The 1st explanatory view explaining an operation of the optical probe of drawing 11
[Drawing 13]The 2nd explanatory view explaining an operation of the optical probe of drawing 11
[Drawing 14]The lineblock diagram showing the composition of the important section of the 1st modification of the optical probe of drawing 11
[Drawing 15]The lineblock diagram showing the composition of the important section of the 2nd modification of the optical probe of drawing 11
[Drawing 16]The lineblock diagram showing the composition of the important section of the 3rd modification of the optical probe of drawing 11
[Drawing 17]The lineblock diagram showing the composition of the important section of the 4th modification of the optical probe of drawing 11
[Drawing 18]The lineblock diagram showing the composition of the important section of the optical probe concerning a 6th embodiment of this invention
[Drawing 19]The figure showing the modification of the bearing of drawing 18
[Drawing 20]The lineblock diagram showing the composition of the important section of the optical probe concerning a 7th embodiment of this invention
[Drawing 21]The explanatory view explaining pouring of the fluid for the index matching into the optical sheath of drawing 20
[Drawing 22]The lineblock diagram showing the composition of the cellular trap of drawing 20
[Drawing 23]The lineblock diagram showing the composition of the 1st modification of the cellular trap of drawing 20
[Drawing 24]The lineblock diagram showing the composition of the 2nd modification of the cellular trap of drawing 20

[Drawing 25]The lineblock diagram showing the composition of the 3rd modification of the cellular trap of drawing 20
[Drawing 26]The 1st explanatory view explaining an operation of the optical probe of drawing 20
[Drawing 27]The 2nd explanatory view explaining an operation of the optical probe of drawing 20
[Drawing 28]The lineblock diagram showing the composition of the important section of the modification of the optical probe of drawing 20
[Drawing 29]Drawing 1 explaining the modification of pouring of the fluid for the index matching into the optical sheath of drawing 21
[Drawing 30]Drawing 2 explaining the modification of pouring of the fluid for the index matching into the optical sheath of drawing 21
[Drawing 31]Drawing 3 explaining the modification of pouring of the fluid for the index matching into the optical sheath of drawing 21
[Drawing 32]The lineblock diagram showing the composition of the important section of the optical probe concerning an 8th embodiment of this invention
[Drawing 33]The explanatory view explaining an operation of the optical probe of drawing 32
[Drawing 34]The lineblock diagram showing the composition of the important section of the 1st modification of the optical probe of drawing 32
[Drawing 35]The explanatory view explaining an operation of the optical probe of drawing 34
[Drawing 36]The lineblock diagram showing the composition of the important section of the 2nd modification of the optical probe of drawing 32
[Drawing 37]The lineblock diagram showing the composition of the important section of the optical probe concerning a 9th embodiment of this invention
[Drawing 38]The explanatory view explaining the mesh ring of drawing 37
[Drawing 39]The lineblock diagram showing the composition of the important section of the modification of the optical probe of drawing 37
[Description of Notations]
1A -- Optical imaging instrument
2 -- Low coherence light source
3 -- The 1st single mode fiber
4 -- Optical coupler part
5 -- The 2nd single mode fiber
6 -- Optical rotary joint
7 -- The 3rd single mode fiber
8A -- Optical probe (device)
9 -- Connector area
10 -- The 4th single mode fiber
11 -- Body tissue
13 -- Rotary drive
14 -- Light path length's variable mechanism
16 -- Grating

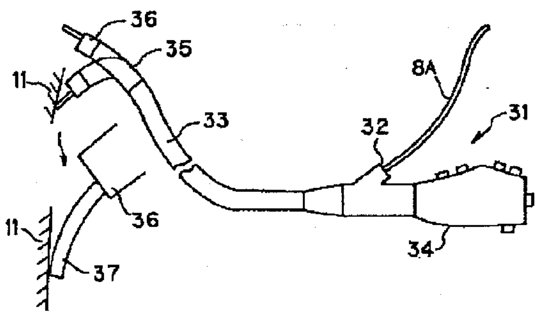
18 -- 1 axis stage
19 -- Galvanometer mirror
20 -- Galvanometer controller
21 -- Position control apparatus
26 -- Monitor
25 -- Computer
27 -- Observation device
38 -- Optical sheath
39 -- Tip unit
40 -- Flexible shaft
51 -- Prism
52 -- Housing
61 -- Metal sphere
62 -- Point of contact
63 -- Apical surface

DRAWINGS

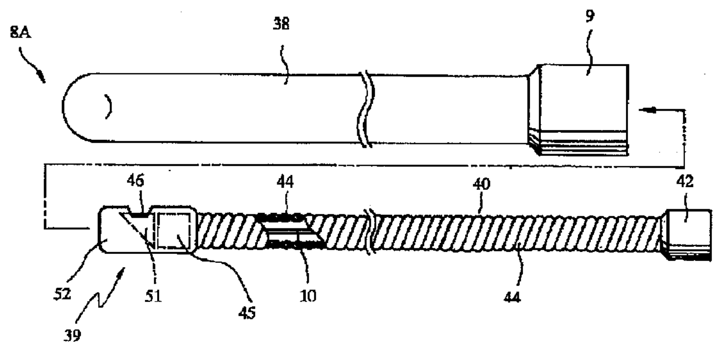
[Drawing 1]



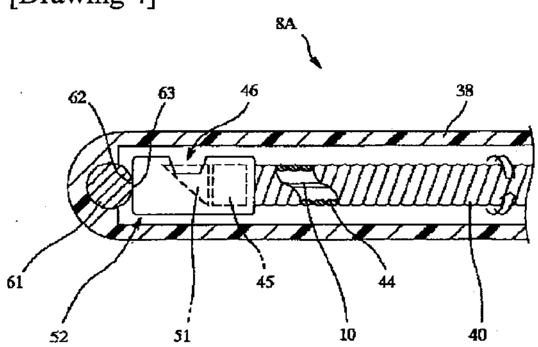
[Drawing 2]



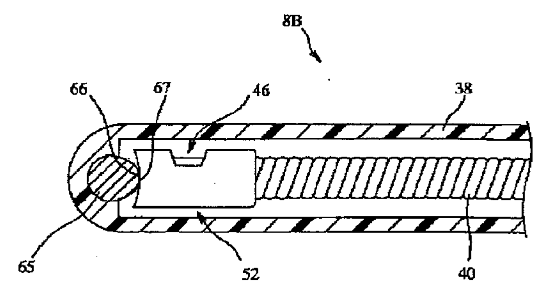
[Drawing 3]



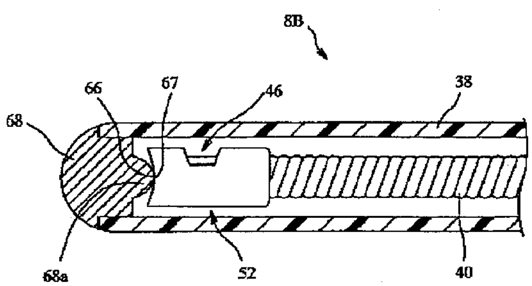
[Drawing 4]



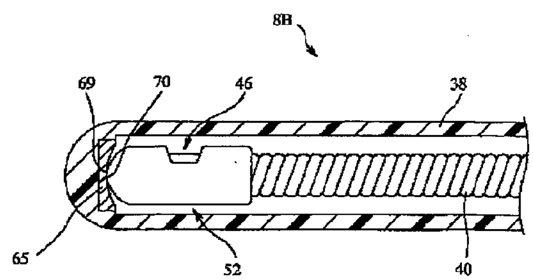
[Drawing 5]



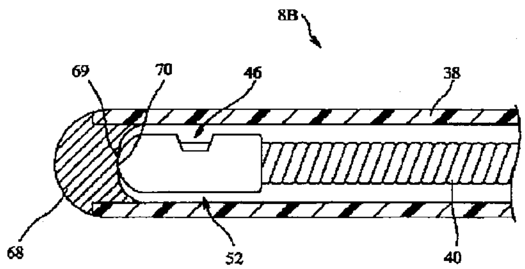
[Drawing 6]



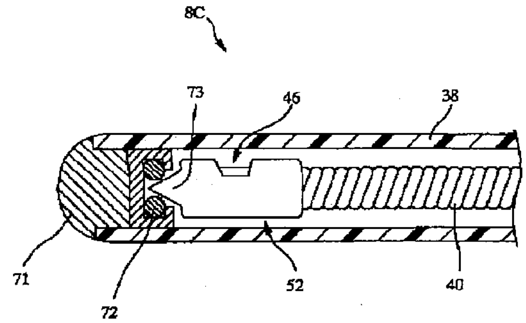
[Drawing 7]



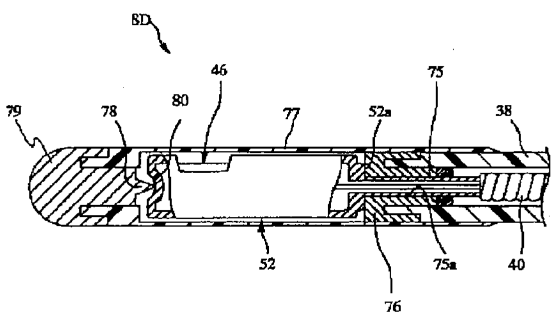
[Drawing 8]



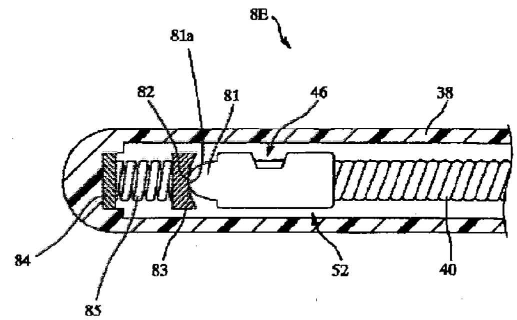
[Drawing 9]



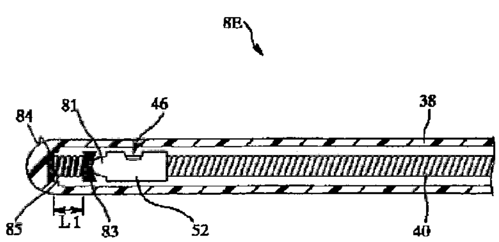
[Drawing 10]



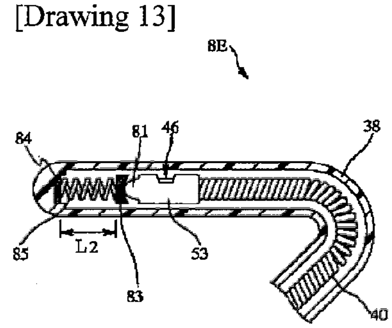
[Drawing 11]



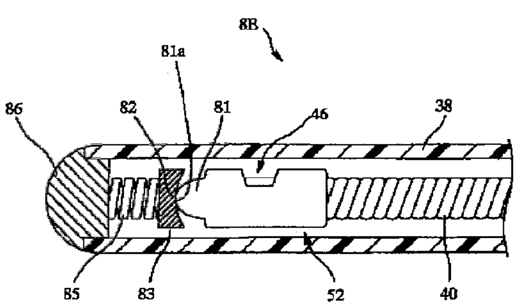
[Drawing 12]



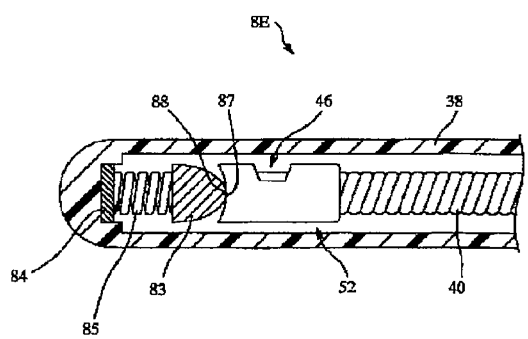
[Drawing 13]



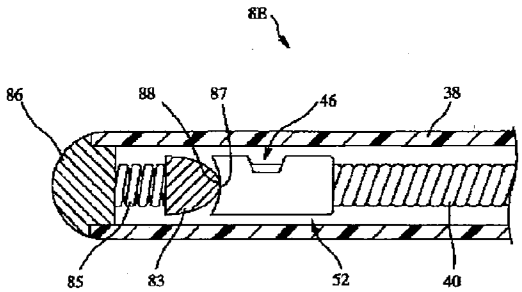
[Drawing 14]



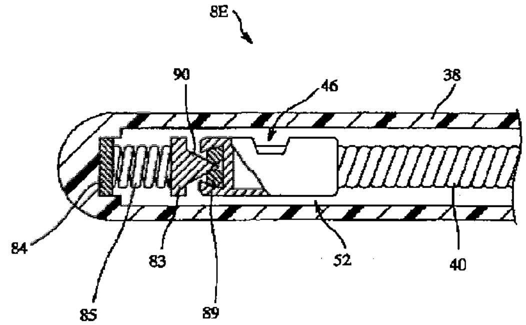
[Drawing 15]



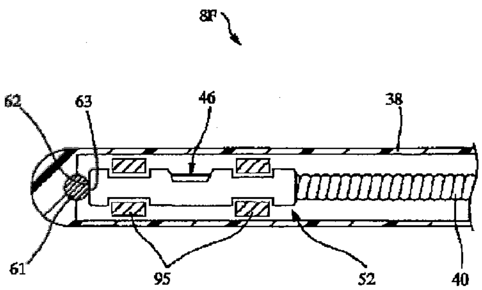
[Drawing 16]



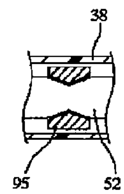
[Drawing 17]



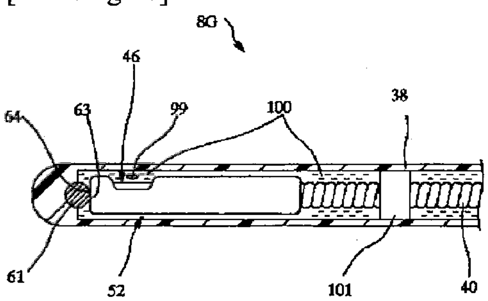
[Drawing 18]



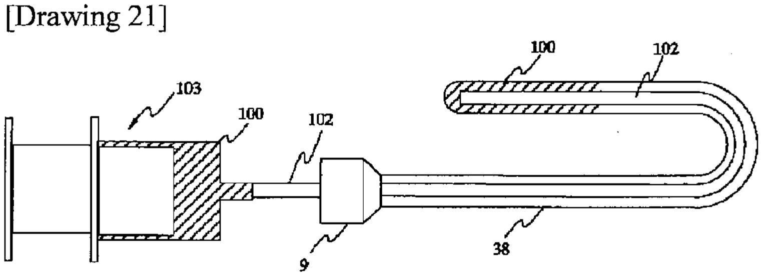
[Drawing 19]



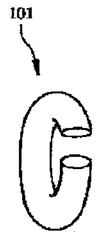
[Drawing 20]



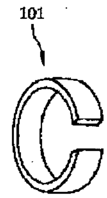
[Drawing 21]



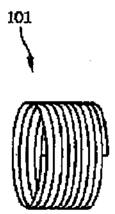
[Drawing 22]



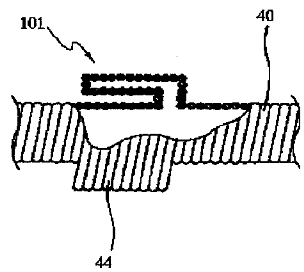
[Drawing 23]



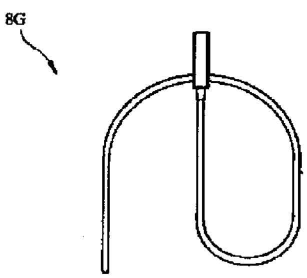
[Drawing 24]



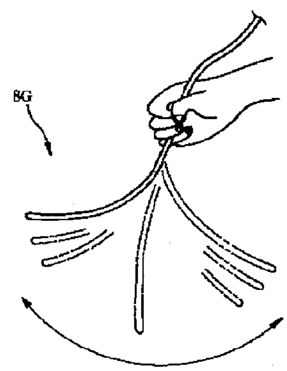
[Drawing 25]



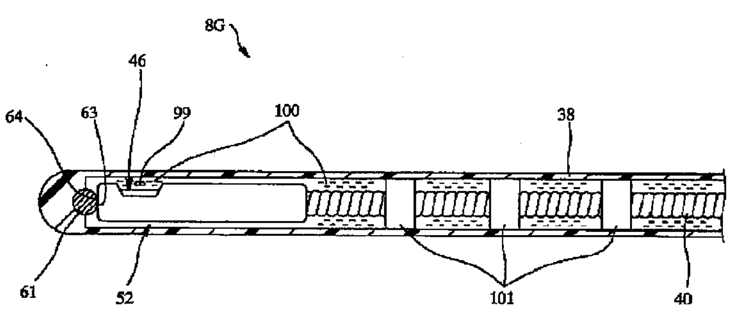
[Drawing 26]



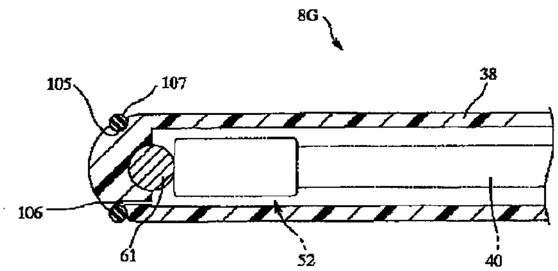
[Drawing 27]



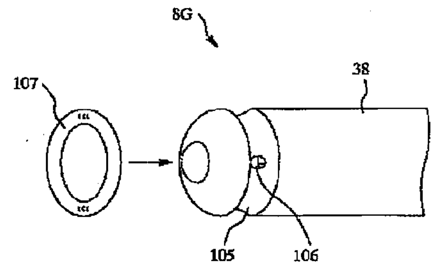
[Drawing 28]



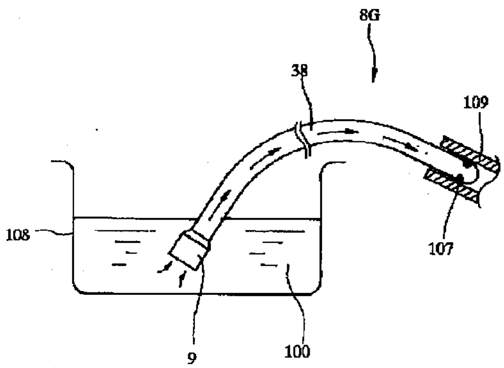
[Drawing 29]



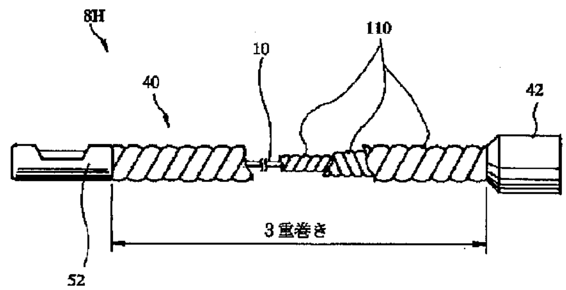
[Drawing 30]



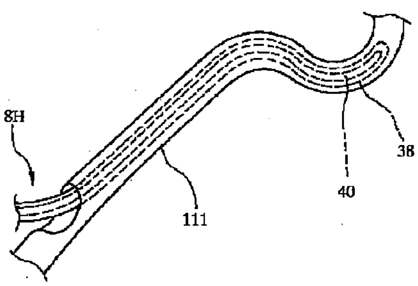
[Drawing 31]



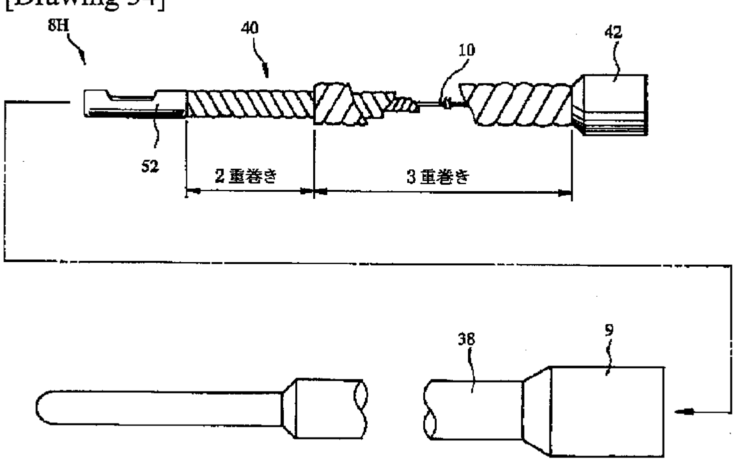
[Drawing 32]



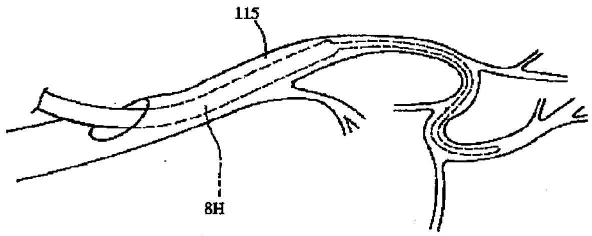
[Drawing 33]



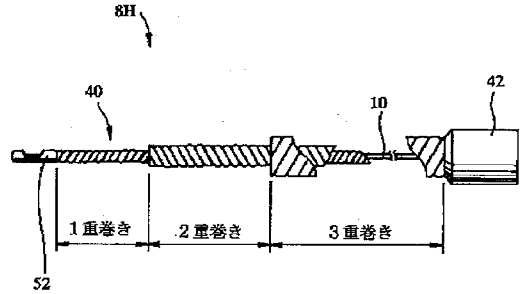
[Drawing 34]



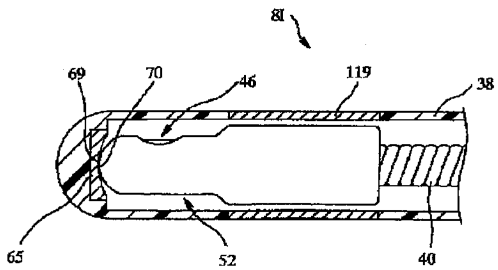
[Drawing 35]



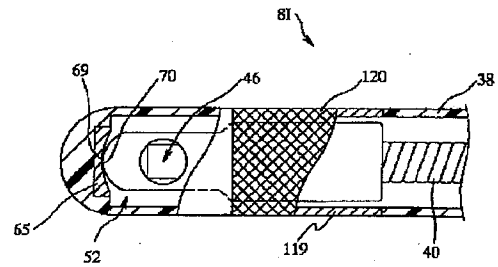
[Drawing 36]



[Drawing 37]



[Drawing 38]



[Drawing 39]